

Correlation between Chemical Evolution and Thermophysical Properties of Cement Pastes: Influence of Temperature and Water/Binder Ratio

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At early ages, hydration of concrete is characterised by an important heat release due to the exothermic character of hydration reactions. This heat release causes deformations of the material and can create cracks and micro-cracks in large concrete structures. Such cracking can lead to a loss of durability for concrete structures. In order to predict those thermally-induced deformations and avoid cracking, it is important to clearly define the thermal behavior evolution of the reactive component of concrete, in other words: cement paste. This study deals with the evolution of thermophysical properties (thermal conductivity and specific heat) of cement paste. A specific instrumentation has been developed in our laboratory in order to measure these two properties during cement hydration. The device is based on the “hot wire method”. A water circulation system connected to a thermostated bath enables tests to be carried out at different isothermal curing temperatures. Measurements start immediately after mixing of cement and water. At the same time, the hydration degree of cement paste has been monitored by means of Thermogravimetric Analysis. The experimental results show an evolution of thermal properties of cement paste during hydration. Both the curing temperature and the water-to-binder ratio influence this evolution. A model is proposed to apply these results to fresh concrete, taking account of the presence of aggregates.